CBC group: sources and searches

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CBC Sources

CBC = compact binary coalescences, or binary systems of compact stars (NS-NS, NS-BH, BH-BH) which coalesce in a "short time".

Coalescence frequency:

$f_{coal} \sim 1600$ Hz $(2.8 M_s/M_{tot}) \sim 40$ Hz $(120\ M_s/M_{tot})$

What do we know about populations?

~ 1500 pulsars ⇒ neutron stars exist!

~ 8 DNS pulsars ⇒ NS binaries exist!

~ 3 will coalesce in less than 10 Gy ⇒ NS-NS mergers exist!

No such hard observations of stellar mass BHs…

CBC rates

- Predictions for detection rate (N/T) are determined by galactic rates R, and number of galaxies observed, N_G: $N/T = R \times N_G$
- Galactic rate for BNS deduced from 3 DNS pulsar systems. KKL ApJL 2004, "reference model":
  - R_{pk} = 83/Myr
  - $R_{95\%}$ = [17-300]/Myr
  - Other models: R_{pk} = [4-200]/Myr
- Sensitivity is parameterized by "horizon distance" D for a low enough false alarm rate (SNR). If D>50 Mpc, N_G can be determined from uniform density of 'blue light" (see C. Hanna's talk later today), and

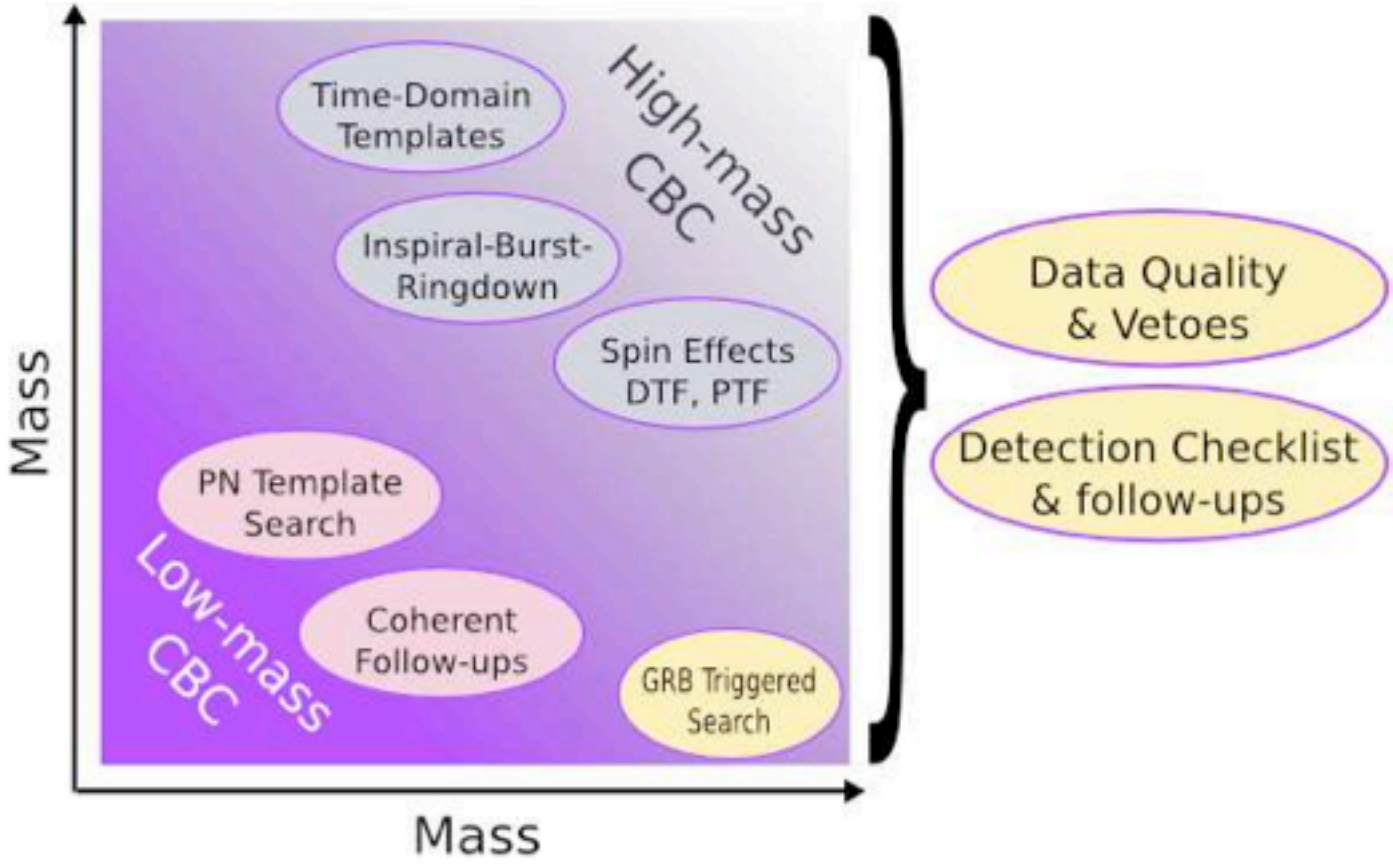
$$N/T \sim 0.05 \times (R/83/\mathrm{Myr}) \times (D/50\ \mathrm{Mpc})^3$$

Using R = 83/Myr,

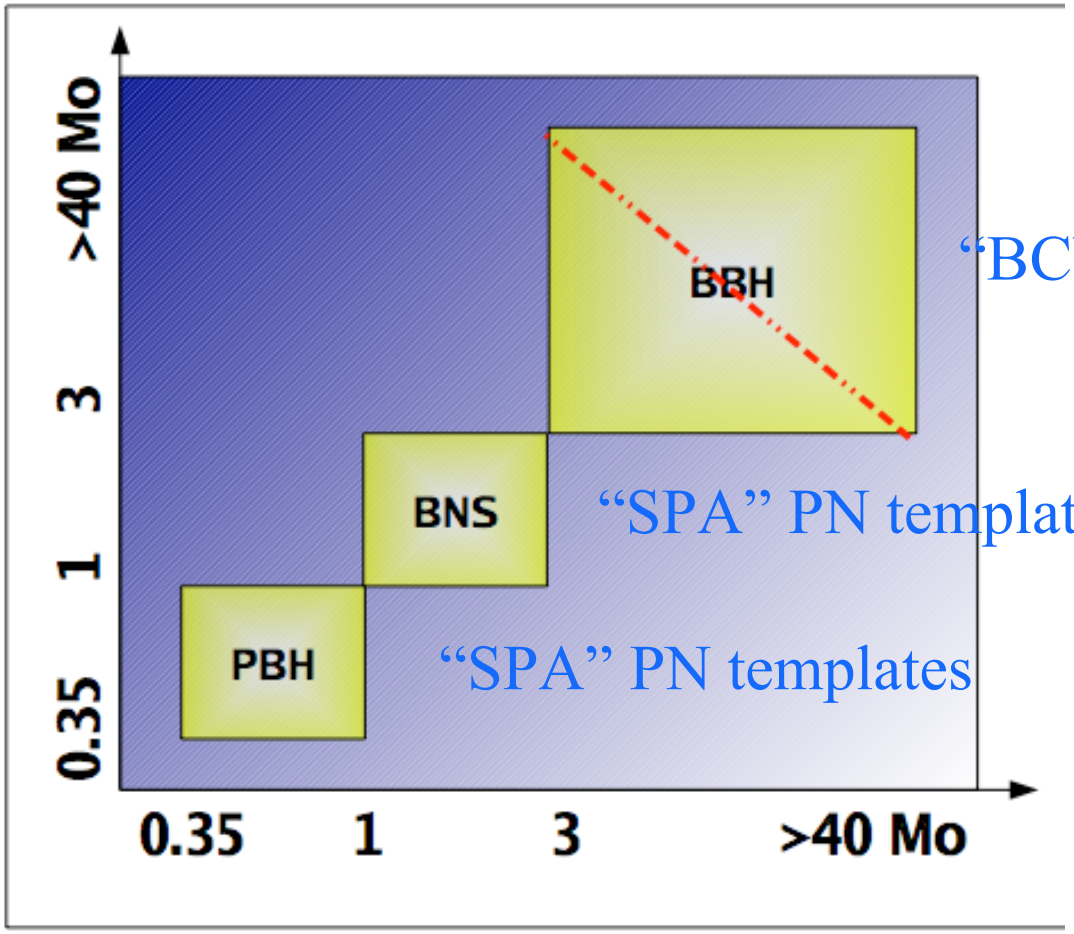
- For initial LIGO, 14 Mpc "Sensemon" (SNR 8)
  $\Rightarrow$ **D ~ 30 Mpc and N/T ~ 1/100 yr**
- **For D ~ 60 Mpc ("enhanced LIGO"), N/T ~ 1/10yr**
- **For D ~ 200x√5 Mpc (Advanced LIGO), N/T ~ 40/yr**

- Black Hole galactic rate much more uncertain: R_{pk} ~ 1/Myr ?
- Sensitivity for BHs at same SNR is larger (but see later S4 result).

CBC sources/searches map



S3/S4 search map



"BCV" templates

"SPA" PN templates

"SPA" PN templates

S3/S4 joint paper results

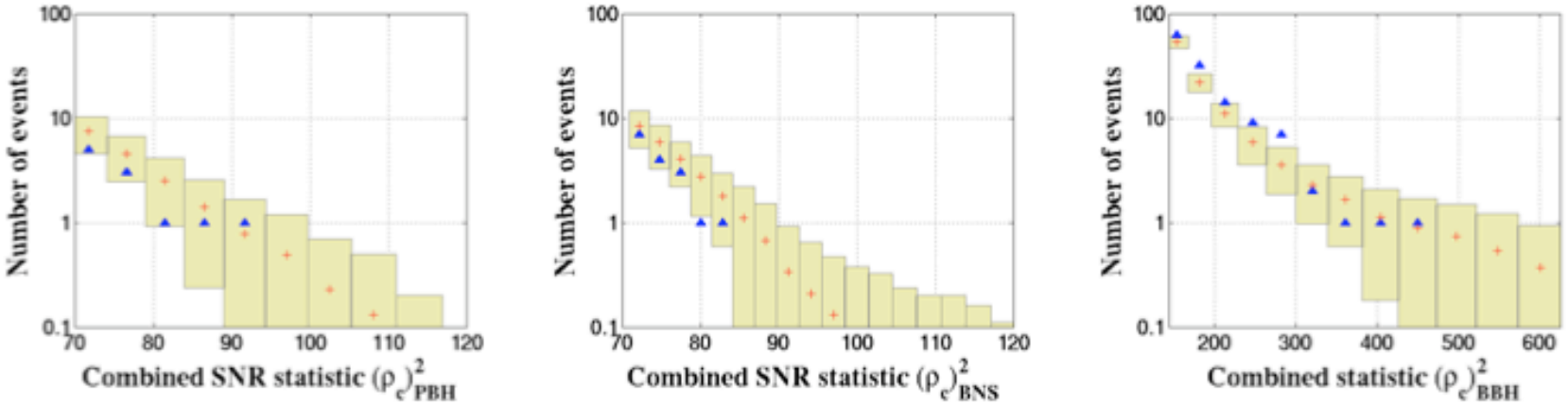


FIG. 3: Cumulative histograms of the combined SNR, ρ_c, for in-time coincident candidates events (triangles) and estimated background from accidental coincidences (crosses and 1 standard-deviation ranges), for the S4 PBH binary (left), S4 BNS (middle) and S4 BBH (right) searches. The loudest candidate, in each search, has an accidental coincidence rate of about 1 during the entire S4 run (576 hours).

S3/S4 joint paper results

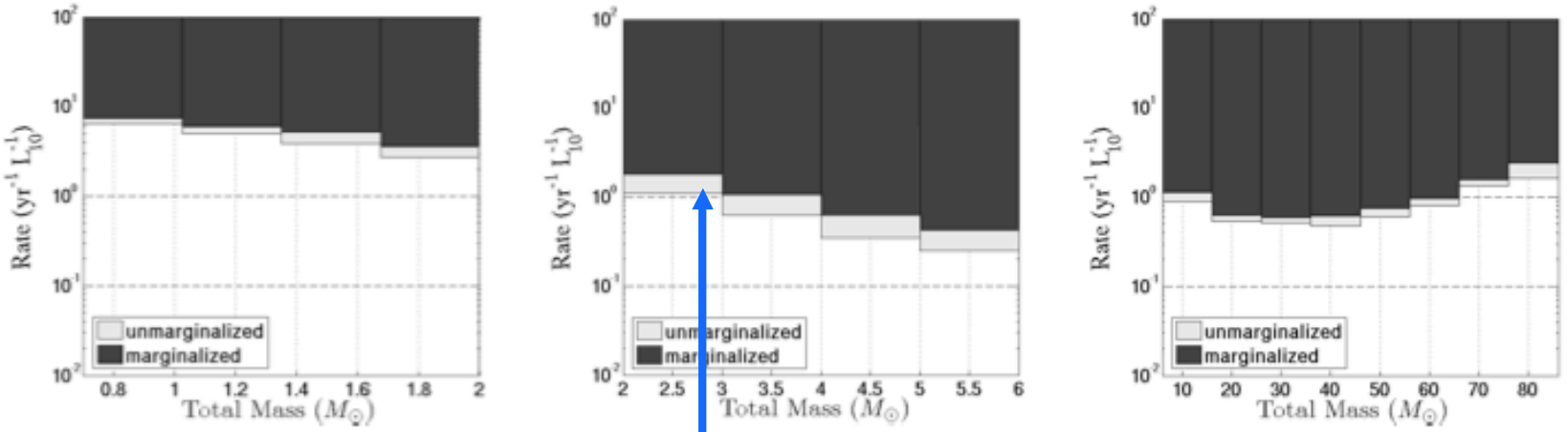


FIG. 5: Upper limits on the binary inspiral coalescence rate per L_{10} as a function of total mass of the binary, for PBH binaries (left), BNS (middle) and BBH (right) searches using non-playground data. The darker area shows the excluded region after accounting for marginalization over estimated systematic errors, and the lighter area is excluded if systematic errors are ignored. In the PBH binary and BNS searches, expected horizon distance is proportional to the total mass of the system (See Fig. 1) but for BBH systems, the horizon distance increase up to about 30 solar mass where signals become shorter and shorter. This drop can be seen in the final upper limit results as well (right panel).

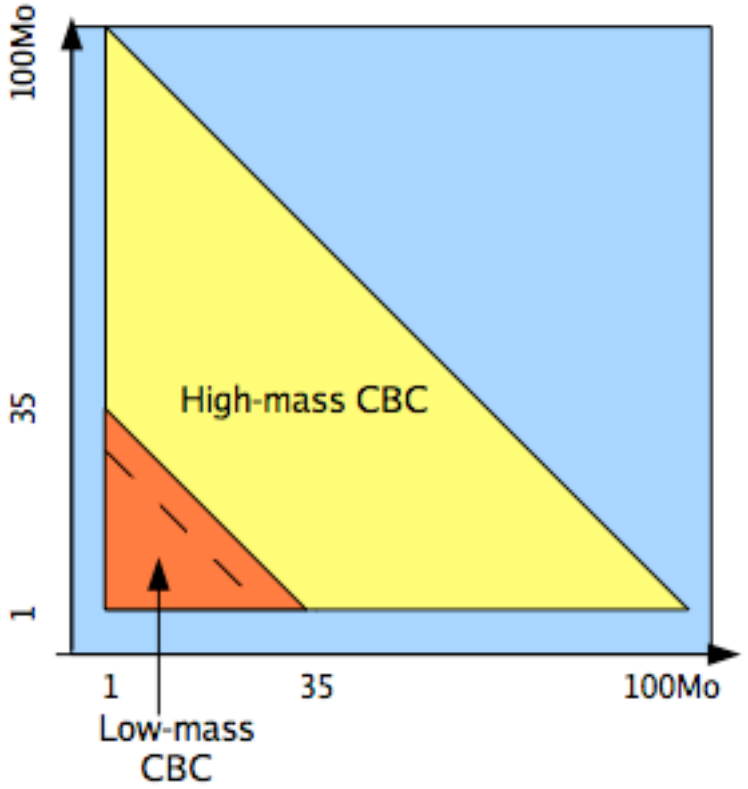
Compare with BNS rate R_{pk} ~ 83/Myr/MWEG ~ 50 /Myr/L_{10}

Recent runs searches

- "First time" searches:
  - » S3 spinning black holes, using BCV templates (G. Jones): results presented in Amaldi, paper draft in review, thesis in preparation
  - » S4 ringdowns, using "time domain" (f,Q) templates (L. Goggin): preliminary results presented in Amaldi, final results presented in Cascina and later today, paper and thesis in preparation.

S5 searches in progress

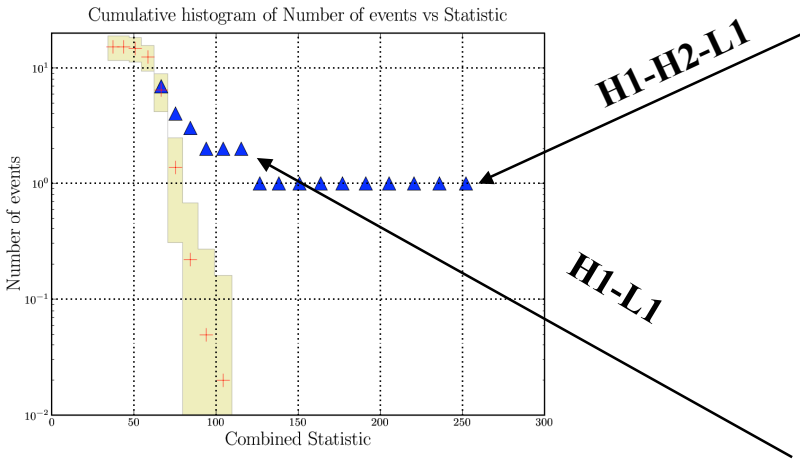
- Low mass CBC
  - D. Keppel, T. Cokelaer
  - Uses PN templates, χ^2 vetoes
  - Looking at playground results
- High Mass CBC
  - C. Robinson/A. Sengupta, C. Hanna
  - Uses “EOB” templates
  - Playground results
  - Possible signal-based vetoes



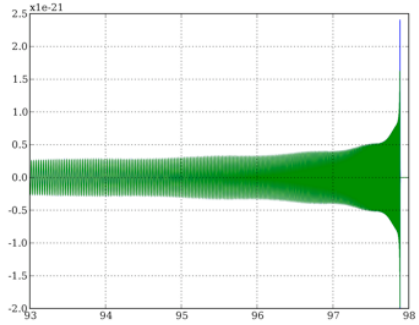
- Vetoes/DQ (joint w/ Burst group): J. Slutsky, L. Cadonati
- Follow up checklist (R. Gouaty, E. Messaritaki)
- Studies on spinning systems:
  - Spinning BCV templates (C. Van Der Broek, D. Brown)
  - Physical Template family (D. Fazi, G. Jones)

S5 completed searches

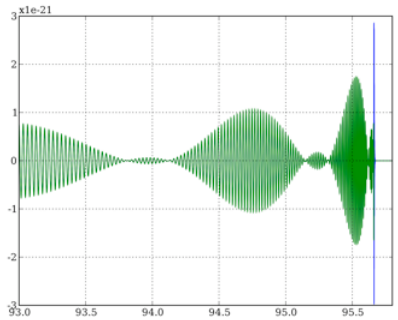
- First “epoch” (3 months): BNS 1-3Ms (D. Brown), BBH 3-30 Ms (E. Messaritaki), using PN templates (no detection).
- GRB 070201: see P. Brady’s talk
- Blind injection test run (48 hrs, June 6-7 2007), using S5 1st year pipeline.



D~64/70 Mpc (H/L),
5-5 Ms,
a~0.1,0.2



D~40/70 Mpc,
17-4 Ms,
a~0.9, 0.04



More S5 searches/activities

- LSC-Virgo search (see Amaldi presentation): 1-3 Ms, pipelines being tested on WSR8; F. Marion, G. Guidi, R. Gouaty, R. Vaulin
- Triggered GRB search (A. Dietz, N. Fotopoulos)
- Automated pipeline being prepared for obtaining weekly results. It incorporates some automated follow up checks.
- Other searches expected, not yet started:
  - Ringdowns
  - Inspiral-Merger-Ringdown strategies/waveforms